Readout of Run2b Outer Layer Modules

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Abstract: The readout results for the first four Run2b outer layer modules are described.

Figure 1: Outer Layer 20-20Axial Module

The Outer Layers (Layers 2-5) of the Run2b D0 silicon detector are constructed from identical staves; there is only one stave design. Each stave contains of 4 different types of modules: 10-10Axial, 20-20Axial, 10-10Stereo, 20-20Stereo. The 20-20Axial module is shown in Figure 1. The same sensor type is used all outer layer modules. All results presented in this note were obtained with Hamamatsu sensors. As of today, Feb 22nd, we have built four outer layer modules, one of each type. A module consists of one readout hybrid, equipped with 10 SVX4 chips, which is connected to either 2 or 4 silicon sensors. All these components have been tested individually as explained elsewhere. The electrical testing of modules allows us to

- Verify that the assembly was successful and that sensors and hybrids were not damaged during construction. Spot bad additional sensor channels, like pin-holes.
- Measure the total and differential noise of readout channels and thus to verify our signal-to-noise ratio before and after irradiation.

All four modules were readout and tested ok, except for the 20-20Stereo module that is currently being debugged. As an example, we show the results from the 20-20axial module. Figure 2 shows the readout of the module. Not all chips have been connected to the same number of sensors. Chips 1-2 and 8-10 are connected to a daisy-chain of two sensors, chips 4-7 are connected to one sensors and chip 3 is not connected to any sensor. The noise performance of chip3 is typical for a bare hybrid.
The dependency of the noise on the capacitive input load can be derived from these data as indicated in figure 4. The noise characteristics of the SVX4 chip is ENC = 500 e- + 40 e-/pF[1]. Comparing chips connected to different number of sensors, we observe the usual linear dependence of the noise on the input capacitance: ENC = 800 e- + 600 e-/sensor. The slightly higher base noise value of modules compared to the SVX4 number is due to a setup noise of about 600 e-. In the approximation that the noise due to capacitive load dominates, the observed slope corresponds to a capacitive load of 15 pF per depleted sensor. This independent capacitance measurement is in excellent agreement with our estimates (Technical Design Report, page 60) were we expect a total capacitive load of 1.4 pF/cm.

[1] M. Garcia Scivarez, Vertex2002 conference

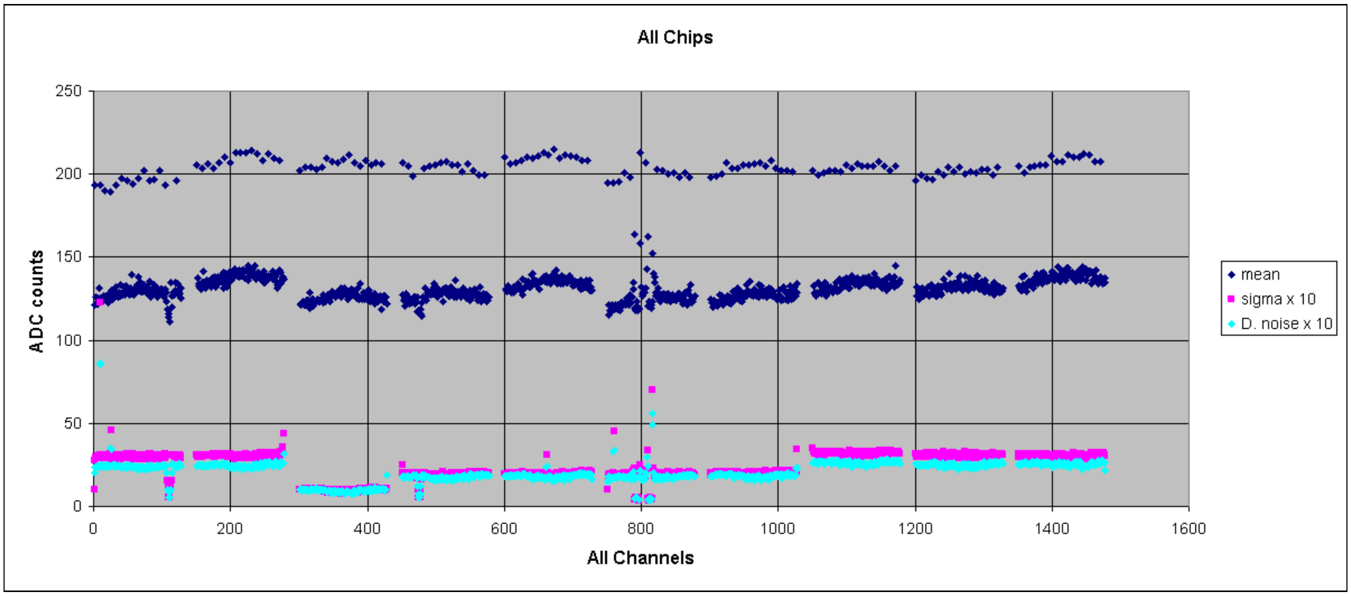

Figure 2: Pedestal Run for an outer layer 20-20Axial module with 50,000 readout events. Dark blue: average pedestal, purple: total noise times ten, turquoise: differential noise times ten. The dependency of the noise on the capacitive input load can be derived from this plot. Chips 1-2 and 8-10 are connected to a daisy-chain of two sensors, chips 4-7 are connected to one sensors and chip 3 is not connected to any sensor. Every 8th readout channel is probed with a calibration voltage (cal-inject mode).

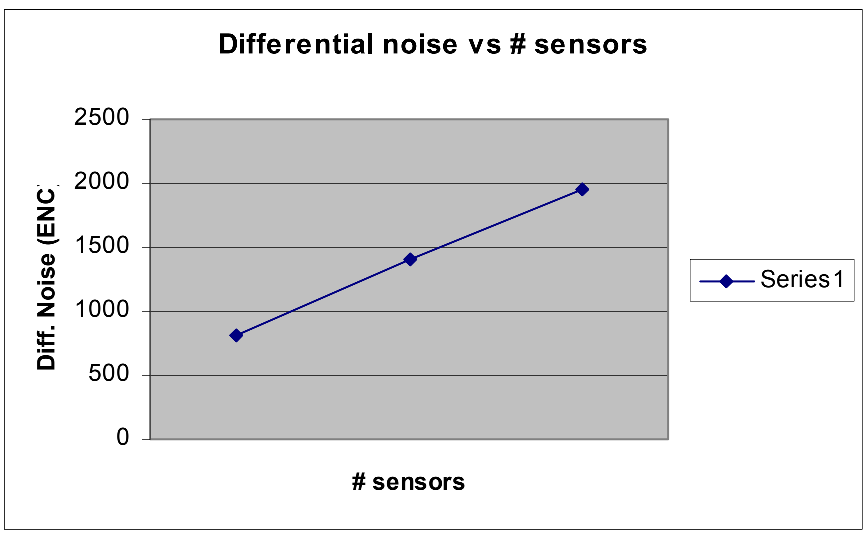

Figure 3: Differential noise vs. number of sensors. The slope corresponds to 15 pF per depleted sensor.

Results with irradiated sensors: One of our modules (10-10Axial) was assembled from sensors that were irradiated with a total flux of 1.23 10^{14} neutron equivalent/cm^2. [2] Applying a bias voltage of 70Volts to deplete the detector and keeping the sensor temperature slightly below 0 ^{o}C, we observe a differential noise of 1400 (+-10%) electrons. This is about the same noise level as for an un-irradiated module with the same number of sensors attached. We do not observe a significant increase in noise after irradiation, as expected.

[2] For details see the documentation on irradiation for the PRR.